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On the Synergy Between Gaia and Transit Surveys

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Abstract

With a nominal launch date of September 2013, ESA's Gaia global astrometry mission will soon herald us into the era of micro-arcsecond-level (μas) precision positional astronomy.

In its all-sky survey, Gaia will monitor astrometrically hundreds of thousands of main-sequence stars within $\approx$ 200 pc, looking for the presence of giant planetary companions within a few AUs from their host stars. Indeed, the wealth of information in the Gaia catalogue of exoplanets will constitute a fundamental contribution to several areas of exoplanet science (e.g., [1]), in particular when seen as a complement to other techniques for planet detection and characterization [2].

I will briefly address some of the relevant technical issues (choose your preferred algorithm, make sure your solution is robust, then double-check using a completely different approach!) associated with the precise and accurate determination of astrometric orbits of planetary systems using Gaia data (see e.g., [3], and references therein, for details).

I will then highlight some of the important synergies between Gaia high-precision astrometry and other on-going and planned, indirect and direct planet-finding and (atmospheric) characterization programs, both from the ground (e.g., HARPS-N, APACHE, SPHERE) and in space (e.g., Kepler, TESS, ECho), and over a broad range of wavelengths, utilizing the connection between Gaia and space-borne and ground-based transit surveys as a proxy. I will particularly focus on the potential for improved understanding of planetary systems orbital architecture and physical properties when Kepler's exquisitely accurate photometry (supported by high-precision ground-based radial-velocity measurements where possible) will be combined with Gaia's superbly precise distance estimates (<1%) for all bright Kepler Objects of Interest (KOIs, $V < 14.5$) in the Kepler field and with the 5-yr time baseline of Gaia astrometry. For example, as a direct consequence of the use of Gaia parallaxes in the Kepler field, the fundamental stellar properties (e.g., masses, radii) of transiting planet hosts in the Kepler field will have to be revised, and this will impact the composition estimates of the planets themselves. Furthermore, being sensitive to giant planetary companions on outer orbits around many of the KOIs, Gaia's astrometric time-series in the Kepler field will help to better the characterization of multiple-planet systems architectures.

The potentially spectacular synergy between Kepler and Gaia will be particularly reinforced given the extension of operations recently granted to Kepler (doubling its mission lifetime), thus providing a significant time interval for 'quasi-simultaneous' observations of the Kepler field with both spacecrafts.

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